pH Meters

Overview of factors that can affect the life of your pH instruments

Proper water analysis is vital to water treatment professionals. Thousands of water samples are being analyzed every day for various factors including pH levels. The right pH instrument allows for accurate and quick water analysis. To ensure proper water testing, it is important to understand the main components of the pH instrument, their function and factors that affect the life of a pH meter and calibration.

What is pH?

The negative logarithm of hydrogen ions in a solution. The ratio of hydrogen ions (H+) and hydroxyl ions (OH-) determine the pH value of a solution. Any hydrogen activity will produce a 59.16 mV/pH unit across the glass membrane. The measurement is expressed on a scale of 0 to 14. Water with a pH of 7 is considered neutral. A solution is considered Acidic when the hydrogen ions (H+) exceed the hydroxyl ions (OH-), and a solution is considered an Alkaline (base) when the hydroxyl ions (OH-) exceed hydrogen ions (H+).

How is pH measured?

A pH instrument consists of three main components (Figure 1): 1) pH measuring cell; 2) reference cell; and 3) display meter.

pH Measuring Cell - Hydrogen sensitive glass blown onto the end of an inert glass stem. A silver wire, treated with silver chloride (Ag/AgCl) is sealed inside the glass (cell) with a solution of potassium chloride saturated with silver chloride. The measuring solution has a neutral pH level of 7 or 0 mV.

A properly hydrated glass sensor will produce a "gel layer" on the inside and outside of the glass membrane, which enables hydrogen ions to develop an electrical potential across the pH glass sensor; a millivolt signal varies with hydrogen ion activity on the glass membrane while submerged in the solution being tested.

Reference cell - A silver wire treated with silver chloride (Ag/AgCl) sealed inside an inert glass housing (cell) with a solution of potassium chloride saturated with silver chloride. The inert glass prevents hydrogen ion activity from test solutions to influence the reference cells constant millivolt signal. The combination of the reference electrode silver-silver chloride wire, and the saturated potassium chloride solution develops a constant 199-millivolt reference signal. The millivolt signal produced inside the reference electrode does not vary as long as the chloride concentration remains constant. The reference voltage is used as a baseline to compare variations or changes in solution being tested. The reference cell is in contact with the test solution through a reference junction that is commonly made of porous Teflon, ceramic, or a wick type material called a pelon strip. This junction completes the measuring circuit of the pH sensor.

Display meter - When the pH sensor is placed in a solution, the pH-measuring cell develops a millivolt signal that reflects the hydrogen ion activity of the test solution. A high-impedance meter accurately measures the small millivolt changes and displays the results in pH units on either an analog or digital display.

FIGURE 1: General Purpose Glass Sensor

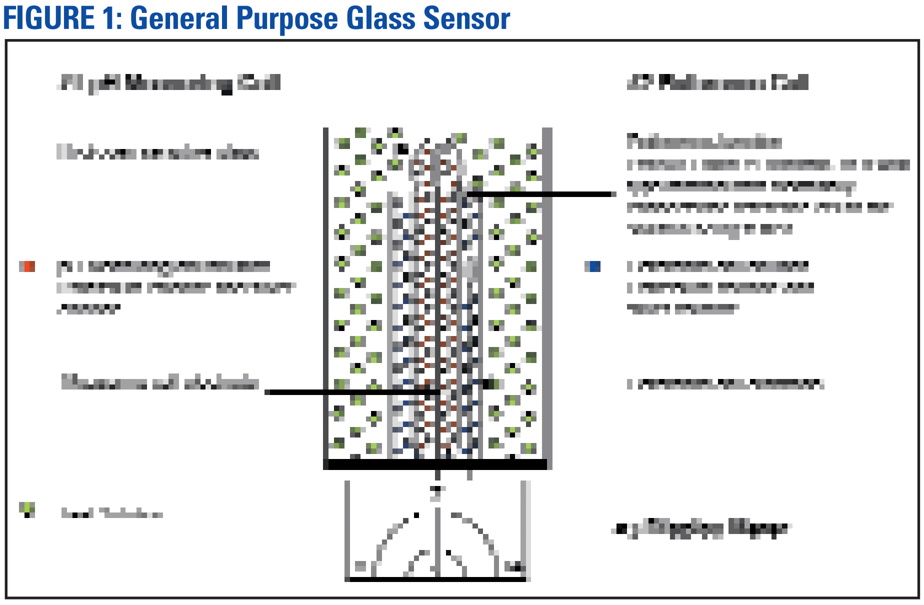
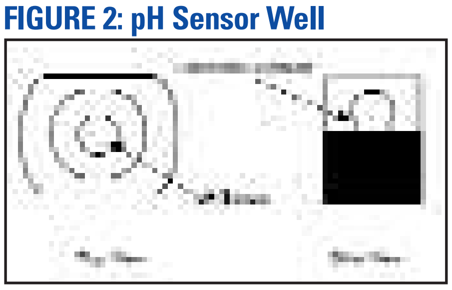


FIGURE 2: pH Sensor Well



Temperature Effects

The pH glass membrane is sensitive to the temperatures of the solution being tested. Prolong use and/or exposure to temperatures above 95° F accelerates the aging and increases chemical attack to the glass membrane which will shorten the overall service life of the meter.

Increased temperatures also decrease the impedance of the glass membrane. The decrease of the impedance affects the millivolt output of a glass membrane. Temperature changes close to neutral usually do not affect pH levels; however, when levels are < pH 3 and > pH 11 a error may occur.

Other Factors

It is important to be aware of other factors that can affect the life of a meter. Because standard glass electrodes are manufactured using a silver / silver chloride electrode inserted into a potassium chloride / silver chloride solution. The following list (not a complete list) of solutions cause the reference solution to precipitate.

- Heavy metals - silver, iron and lead;
- Proteins;
- Low ion solutions - distilled water;
- High sodium concentrates;
- Sulfides; and
- Fluorides (in high concentrations or prolonged use).

Sodium Ion Error

As solutions approach and exceed the pH level of 12, the high concentration of sodium ions interfere with the standard glass membrane and cause pH levels to be displayed lower than actual pH levels. If solutions being tested are normally high alkaline, a probe manufactured with special glass may be required. The special glass may be used throughout the pH range of 0 to 14, but due to its high resistance nature of the glass it will significantly increase the overall time to analyze a sample. Constant use in solutions with pH levels higher than 12 can reduce the life of the probe.

Calibration

The break down of the pH meter electrodes and the depletion, and/or saturation of the reference solution require your pH instrument to be re-calibrated. This should normally be performed twice a month, but depending on the chemistry of the sample, more frequent calibration may be necessary.

Refer to the manufacturers' instruction manual for detailed instructions for specific calibration procedures. The calibration should include the following steps.

The initial calibration should use pH buffer solution 7, this will check and allow the instrument to be adjusted so its output reflects 0 millivolts, neutral or pH 7.

A second calibration using a standard solution that reflects the normal range of solutions being analyzed. If acidic solutions are normally tested, a manufacturers pH buffer solution 4 should be used.

If solutions to be tested are normally alkaline, a pH buffer solution 10 should be used. In most cases it is not necessary to calibrate in all three locations.

Maximize pH Meter's Life

Approximately 90% of all premature pH meter failures can be prevented with the incorporation of a few maintenance procedures.

The following procedures should be performed after using most pH test instruments.

The pH sensor well (Figure 2) must be filled with a manufacturers storage solution. Alternate solutions are available depending upon the manufacturer. Failure to do so will: 1) Allow the glass membrane to dry out. A de-hydrated glass membrane will not produce the necessary "gel layer" on the sensor surface. 2) Allow airborne contaminants to settle on the glass membrane surface. Once contaminants dry onto the surface of the glass membrane it will inhibit the transfer of hydrogen ions; and 3) Allow the reference junction to dry out. The reference junction material is usually a wick or fiber type material that completes the electrical circuit between the reference electrode cell and the solution being tested. Dehydration causes the reference solution to leach out of the electrode cavity, and form crystals in the junction. This is normally referred to as the "bridging effect." Repeated dehydration of the pH meter will cause the instrument to have a slower response time, and be more difficult to calibrate.

Store spare pH meters in a refrigerator. However, do not to allow the temperature to fall below freezing, this will cause the solution to expand, and may damage the electrodes inside the sensor. Storage in a refrigerated environment will slow the evaporation of the storage solution, but not prevent evaporation. Always inspect and replace storage solution in spare meters.

Final Thoughts

Understanding how pH is measured and performing proper calibration and maintenance of your pH meter will maximize its life and ensure accurate water analysis. *wqp*

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Digital pH Meter

This digital pH meter Model 721 is simple to operate and comes in a compact, rugged case with an adjustable viewing angle. It is portable for both laboratory and industrial field applications. It has a range of 0-14 pH and runs on 110 VAC. It comes with an analog output for recording purposes and is complete with pH probe, a removable vertical rod and probe clamp for laboratory operations, and start-up buffer solutions for calibration.

Analytical Measurements
Hillside, NJ • tel: 908.964.8686
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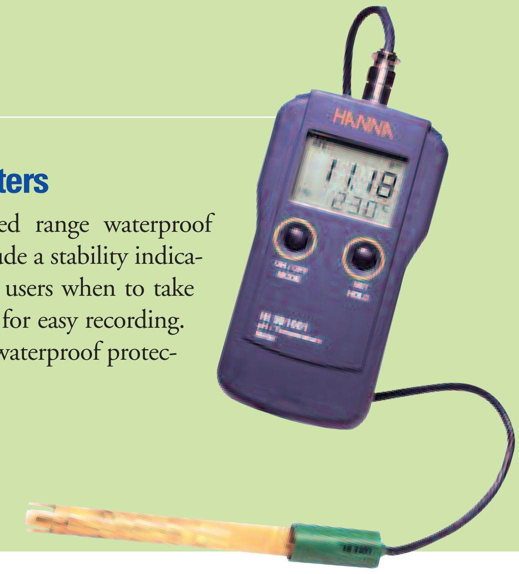
on the cover

pH/ORP/Temperature Meters



The HI 991001/991002 extended range waterproof pH/ORP/temperature meters include a stability indicator and hold feature that prompts users when to take the reading and freezes the display for easy recording. The meters are portable and offer waterproof protection in a compact casing.

Hanna Instruments, Woonsocket, RI
tel: 877.694.2662
www.hannainst.com
write in 1001

UVT Meter

The Real UVT is a UV percent transmittance (UVT) meter that is affordable, portable and easy to use. The Real UVT utilizes a 254 nm UV wavelength and uses advanced technology to maintain calibration over multiple samples. The Real UVT has only a one minute warm-up time, and comes complete with wall and car adapters so you can check the UVT of a water sample anywhere, anytime.

Real Tech Inc., Whitby, ON, Canada
tel: 905.655.9895 • www.realtech.com
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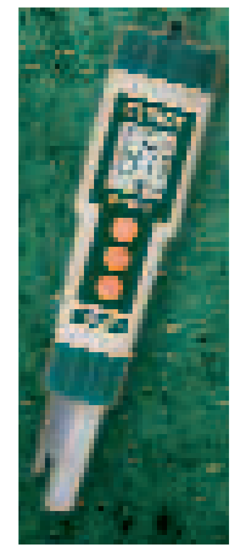
pH/Conductivity Meter

This waterproof ExStikII pH and Conductivity Meter, Model EC500 is designed for HVAC cooling towers, industrial and commercial boilers, reverse osmosis systems, pools and spas. The meter combines a flat surface pH electrode with an auto-ranging accurate conductivity cell to measure conductivity, TDS, salinity, pH and temperature. It delivers seven selectable units of measure: pH, µS, mS, ppm, ppt, mg/L and g/L. It also provides automatic temperature compensation, adjustable conductivity to a TDS ratio from 0.4 to 1.0 and a 0.5 salinity ratio.



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